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PATENT & TRADEMARK OFFICE

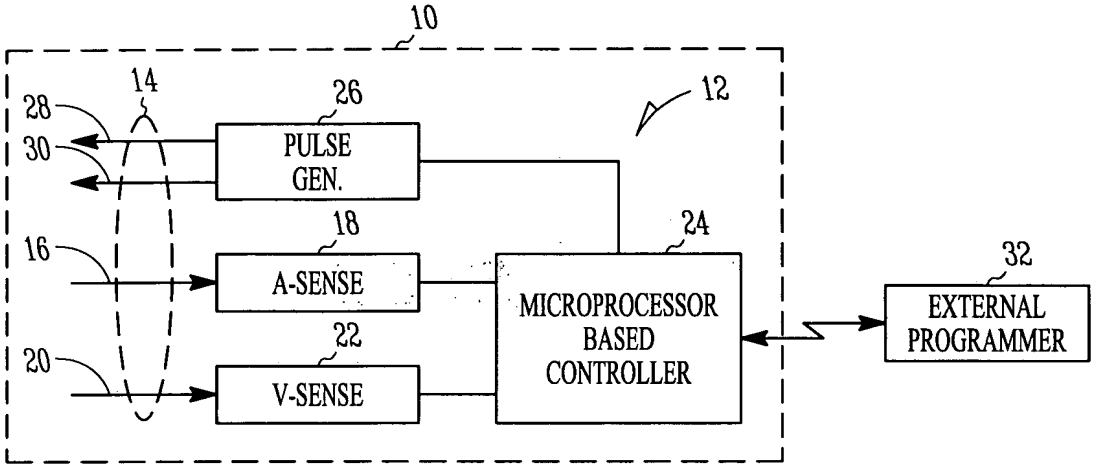

FIG. 1

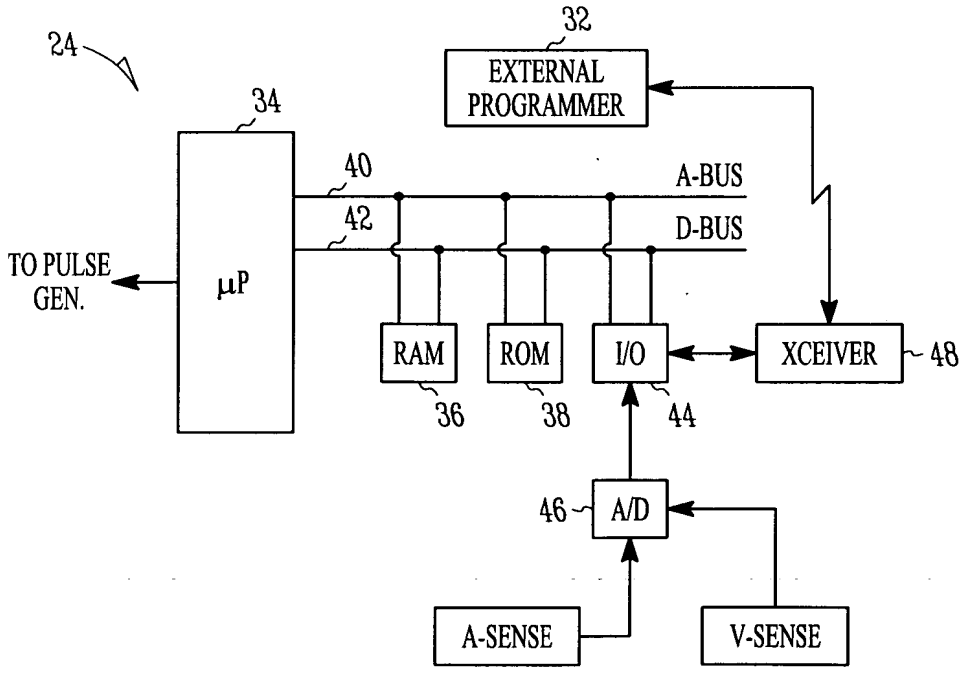

FIG. 2

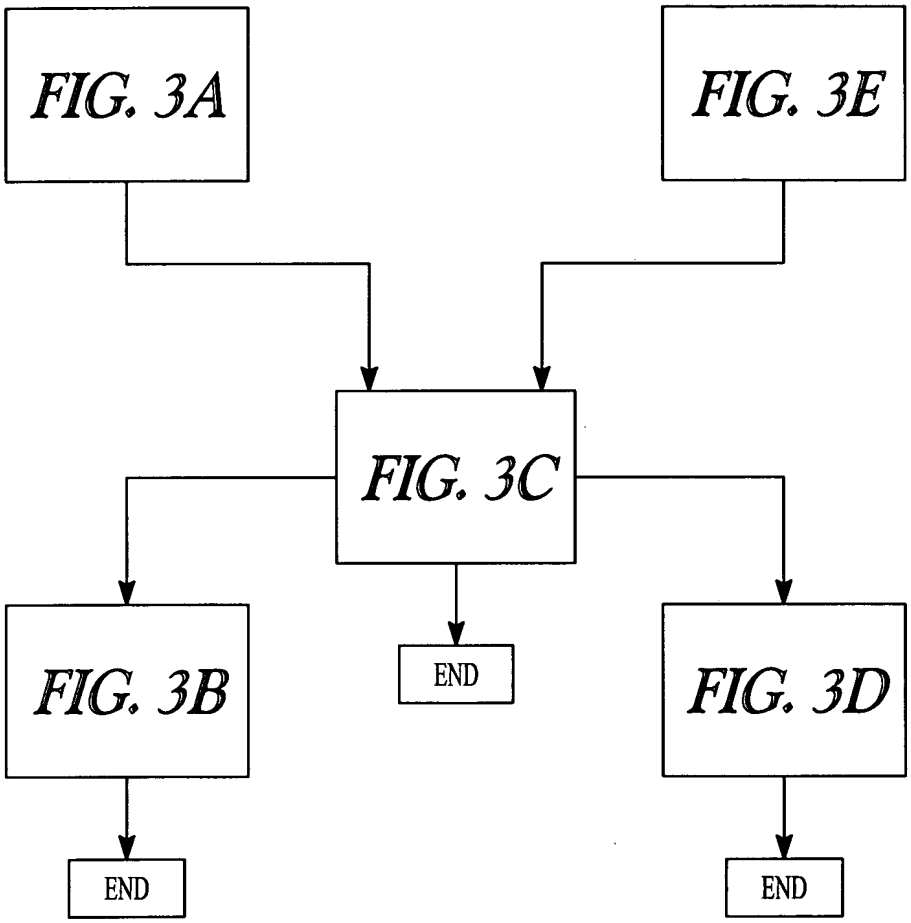

FIG. 3

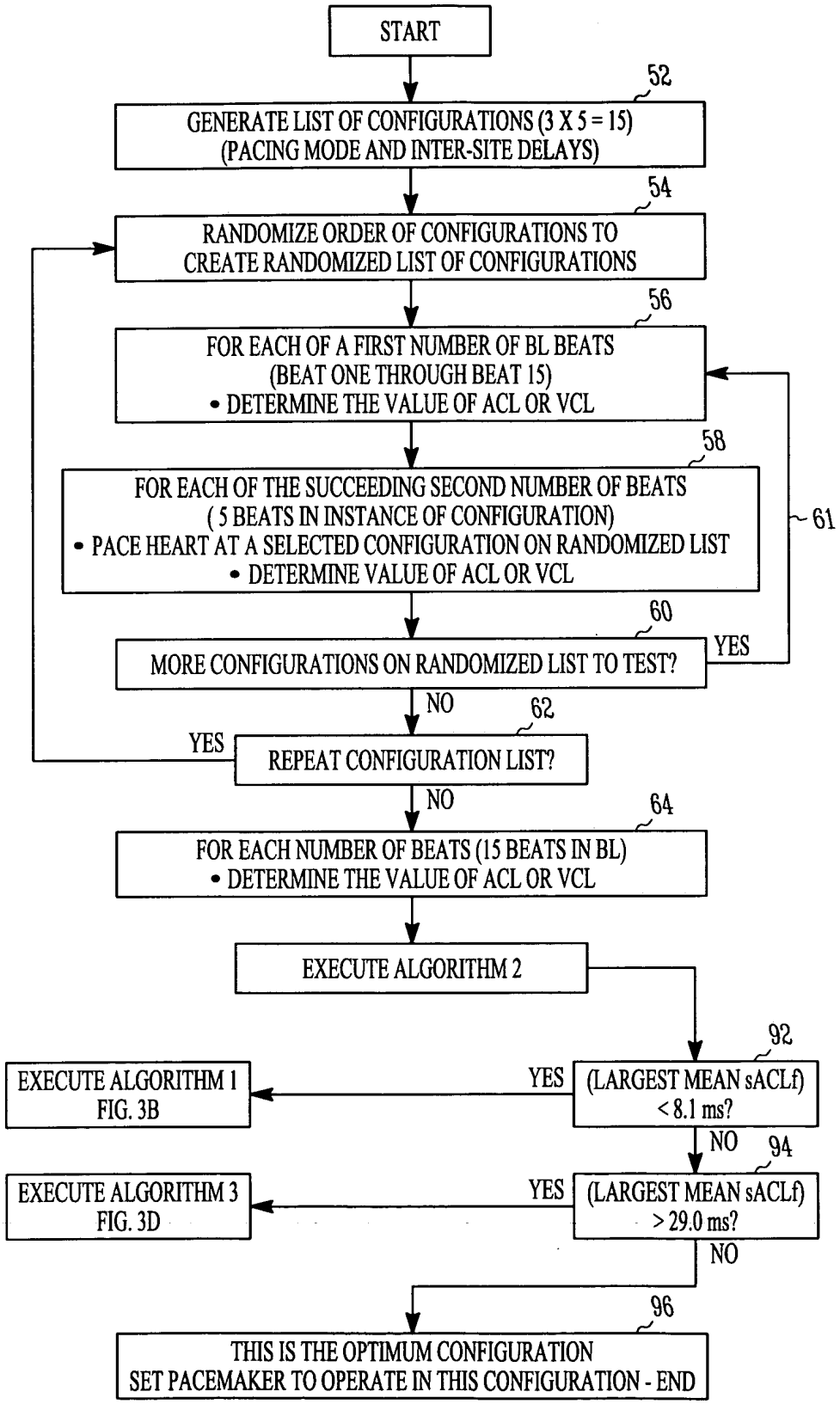
START
52
GENERATE LIST OF CONFIGURATIONS (3 X 5 = 15)
(PACING MODE AND INTER-SITE DELAYS)
54
RANDOMIZE ORDER OF CONFIGURATIONS TO
CREATE RANDOMIZED LIST OF CONFIGURATIONS
56
FOR EACH OF A FIRST NUMBER OF BL BEATS
(BEAT ONE THROUGH BEAT 15)
• DETERMINE THE VALUE OF ACL OR VCL
58
FOR EACH OF THE SUCCEEDING SECOND NUMBER OF BEATS
(5 BEATS IN INSTANCE OF CONFIGURATION)
• PACE HEART AT A SELECTED CONFIGURATION ON RANDOMIZED LIST
• DETERMINE VALUE OF ACL OR VCL
61
60
MORE CONFIGURATIONS ON RANDOMIZED LIST TO TEST?
YES
NO
62
YES
REPEAT CONFIGURATION LIST?
NO
64
FOR EACH NUMBER OF BEATS (15 BEATS IN BL)
• DETERMINE THE VALUE OF ACL OR VCL
EXECUTE ALGORITHM 2
92
EXECUTE ALGORITHM 1
FIG. 3B
YES
(LARGEST MEAN sACLf)
< 8.1 ms?
NO
94
EXECUTE ALGORITHM 3
FIG. 3D
YES
(LARGEST MEAN sACLf)
> 29.0 ms?
NO
96
THIS IS THE OPTIMUM CONFIGURATION
SET PACEMAKER TO OPERATE IN THIS CONFIGURATION - END

FIG. 3A

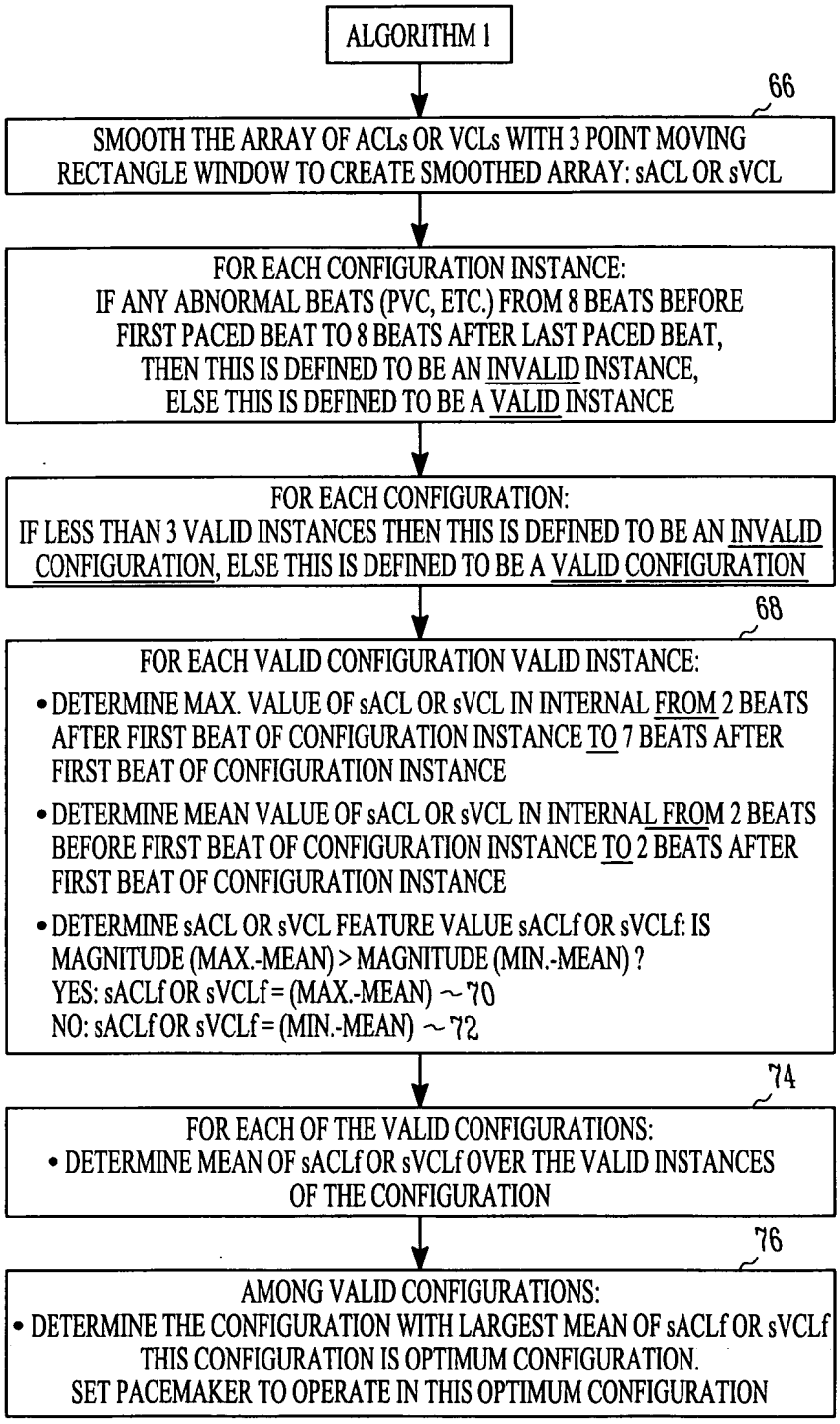
ALGORITHM 1
66
SMOOTH THE ARRAY OF ACLs OR VCLs WITH 3 POINT MOVING RECTANGLE WINDOW TO CREATE SMOOTHED ARRAY: sACL OR sVCL
FOR EACH CONFIGURATION INSTANCE:
IF ANY ABNORMAL BEATS (PVC, ETC.) FROM 8 BEATS BEFORE FIRST PACED BEAT TO 8 BEATS AFTER LAST PACED BEAT, THEN THIS IS DEFINED TO BE AN INVALID INSTANCE, ELSE THIS IS DEFINED TO BE A VALID INSTANCE
FOR EACH CONFIGURATION:
IF LESS THAN 3 VALID INSTANCES THEN THIS IS DEFINED TO BE AN INVALID CONFIGURATION, ELSE THIS IS DEFINED TO BE A VALID CONFIGURATION
68
FOR EACH VALID CONFIGURATION VALID INSTANCE:
• DETERMINE MAX. VALUE OF sACL OR sVCL IN INTERNAL FROM 2 BEATS AFTER FIRST BEAT OF CONFIGURATION INSTANCE TO 7 BEATS AFTER FIRST BEAT OF CONFIGURATION INSTANCE
• DETERMINE MEAN VALUE OF sACL OR sVCL IN INTERNAL FROM 2 BEATS BEFORE FIRST BEAT OF CONFIGURATION INSTANCE TO 2 BEATS AFTER FIRST BEAT OF CONFIGURATION INSTANCE
• DETERMINE sACL OR sVCL FEATURE VALUE sACLf OR sVCLf: IS MAGNITUDE (MAX.-MEAN) > MAGNITUDE (MIN.-MEAN) ?
YES: sACLf OR sVCLf = (MAX.-MEAN) ~70
NO: sACLf OR sVCLf = (MIN.-MEAN) ~72
74
FOR EACH OF THE VALID CONFIGURATIONS:
• DETERMINE MEAN OF sACLf OR sVCLf OVER THE VALID INSTANCES OF THE CONFIGURATION
76
AMONG VALID CONFIGURATIONS:
• DETERMINE THE CONFIGURATION WITH LARGEST MEAN OF sACLf OR sVCLf
THIS CONFIGURATION IS OPTIMUM CONFIGURATION.
SET PACEMAKER TO OPERATE IN THIS OPTIMUM CONFIGURATION

FIG. 3B

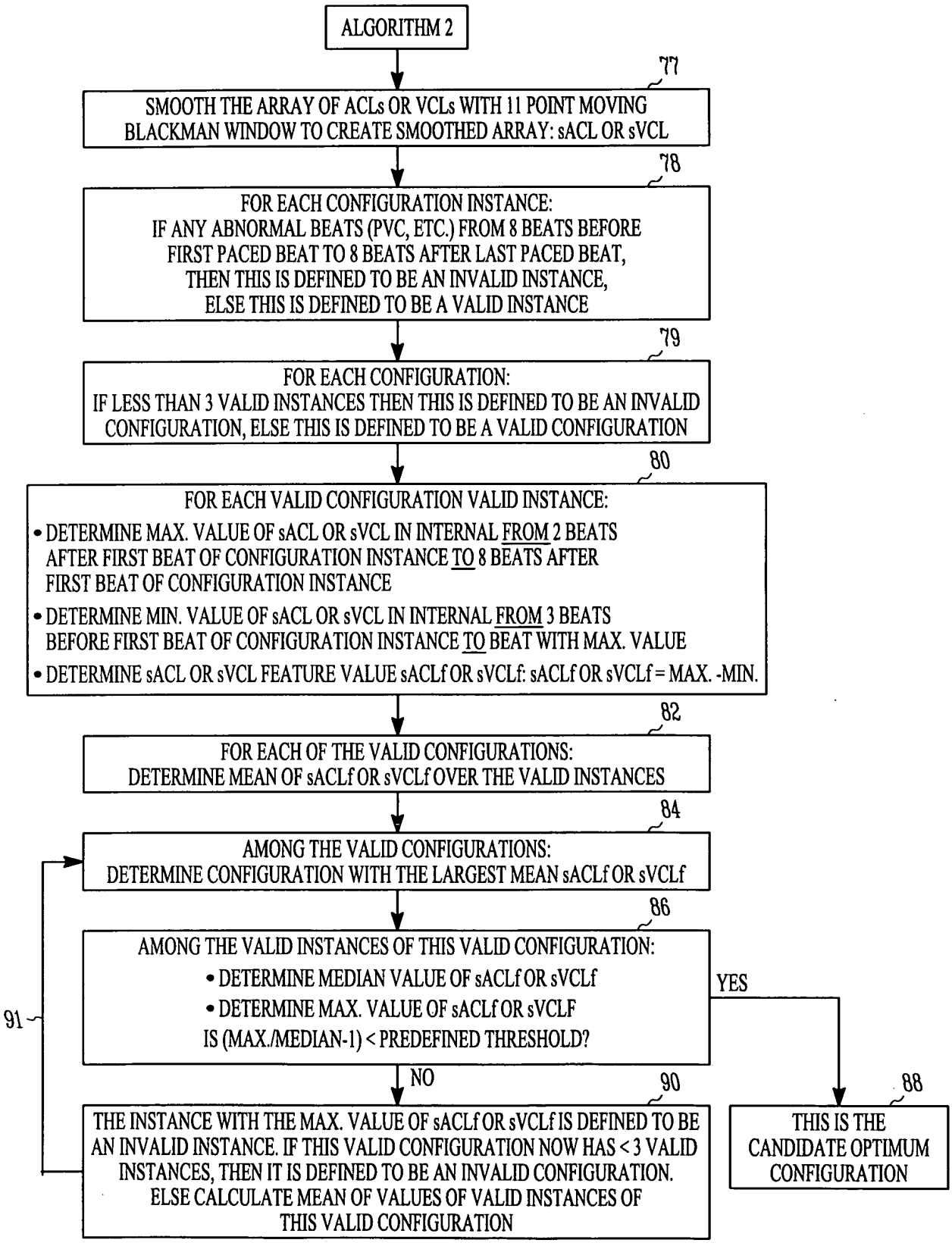
ALGORITHM 2
77
SMOOTH THE ARRAY OF ACLs OR VCLs WITH 11 POINT MOVING BLACKMAN WINDOW TO CREATE SMOOTHED ARRAY: sACL OR sVCL
78
FOR EACH CONFIGURATION INSTANCE:
IF ANY ABNORMAL BEATS (PVC, ETC.) FROM 8 BEATS BEFORE FIRST PACED BEAT TO 8 BEATS AFTER LAST PACED BEAT, THEN THIS IS DEFINED TO BE AN INVALID INSTANCE, ELSE THIS IS DEFINED TO BE A VALID INSTANCE
79
FOR EACH CONFIGURATION:
IF LESS THAN 3 VALID INSTANCES THEN THIS IS DEFINED TO BE AN INVALID CONFIGURATION, ELSE THIS IS DEFINED TO BE A VALID CONFIGURATION
80
FOR EACH VALID CONFIGURATION VALID INSTANCE:
• DETERMINE MAX. VALUE OF sACL OR sVCL IN INTERNAL FROM 2 BEATS AFTER FIRST BEAT OF CONFIGURATION INSTANCE TO 8 BEATS AFTER FIRST BEAT OF CONFIGURATION INSTANCE
• DETERMINE MIN. VALUE OF sACL OR sVCL IN INTERNAL FROM 3 BEATS BEFORE FIRST BEAT OF CONFIGURATION INSTANCE TO BEAT WITH MAX. VALUE
• DETERMINE sACL OR sVCL FEATURE VALUE sACLf OR sVCLf: sACLf OR sVCLf = MAX. -MIN.
82
FOR EACH OF THE VALID CONFIGURATIONS:
DETERMINE MEAN OF sACLf OR sVCLf OVER THE VALID INSTANCES
84
AMONG THE VALID CONFIGURATIONS:
DETERMINE CONFIGURATION WITH THE LARGEST MEAN sACLf OR sVCLf
86
AMONG THE VALID INSTANCES OF THIS VALID CONFIGURATION:
• DETERMINE MEDIAN VALUE OF sACLf OR sVCLf
• DETERMINE MAX. VALUE OF sACLf OR sVCLF
IS (MAX./MEDIAN-1) < PREDEFINED THRESHOLD?
YES
NO
88
THIS IS THE CANDIDATE OPTIMUM CONFIGURATION
90
THE INSTANCE WITH THE MAX. VALUE OF sACLf OR sVCLf IS DEFINED TO BE AN INVALID INSTANCE. IF THIS VALID CONFIGURATION NOW HAS < 3 VALID INSTANCES, THEN IT IS DEFINED TO BE AN INVALID CONFIGURATION. ELSE CALCULATE MEAN OF VALUES OF VALID INSTANCES OF THIS VALID CONFIGURATION
91

FIG. 3C

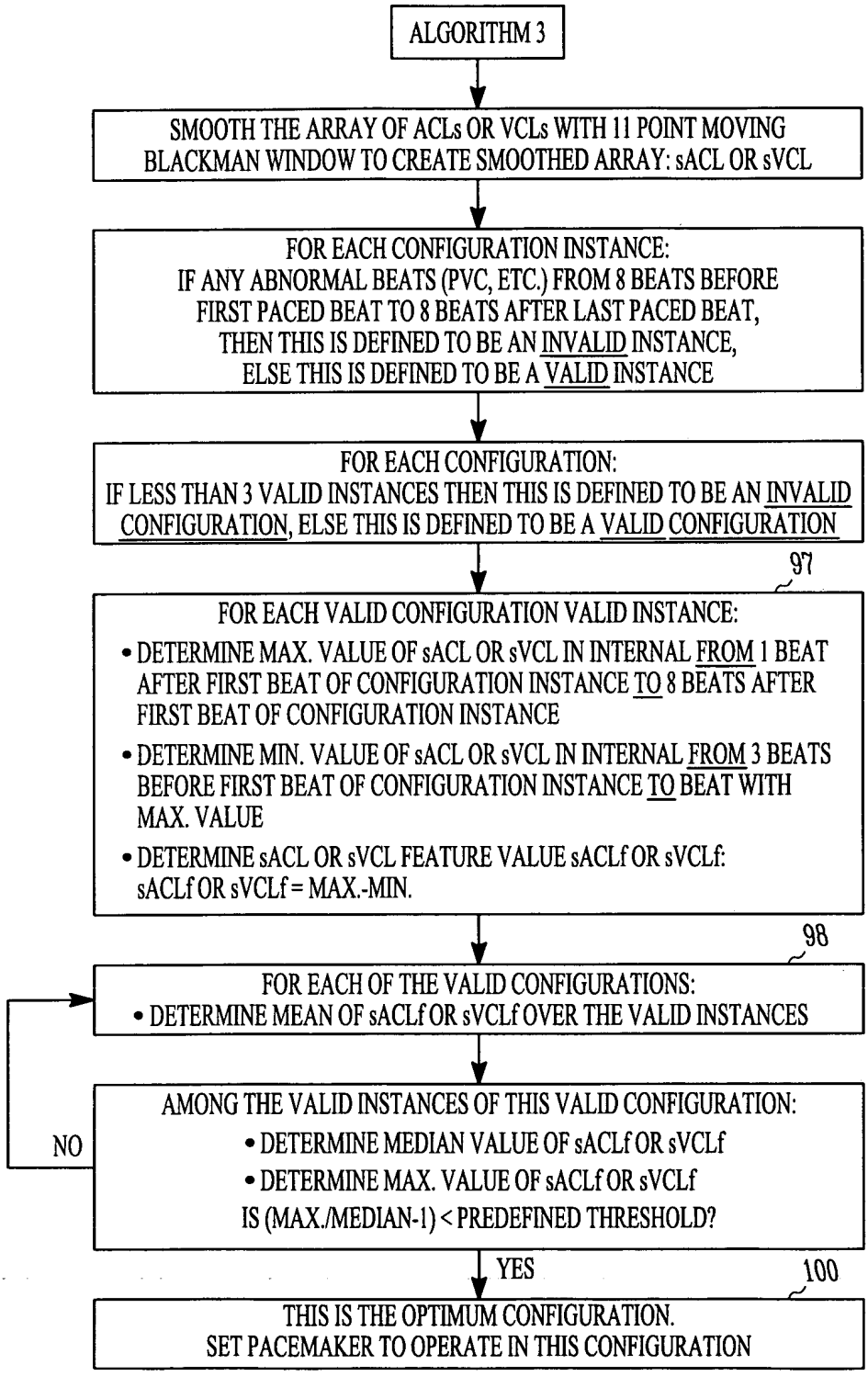
ALGORITHM 3
SMOOTH THE ARRAY OF ACLs OR VCLs WITH 11 POINT MOVING BLACKMAN WINDOW TO CREATE SMOOTHED ARRAY: sACL OR sVCL
FOR EACH CONFIGURATION INSTANCE:
IF ANY ABNORMAL BEATS (PVC, ETC.) FROM 8 BEATS BEFORE FIRST PACED BEAT TO 8 BEATS AFTER LAST PACED BEAT, THEN THIS IS DEFINED TO BE AN INVALID INSTANCE, ELSE THIS IS DEFINED TO BE A VALID INSTANCE
FOR EACH CONFIGURATION:
IF LESS THAN 3 VALID INSTANCES THEN THIS IS DEFINED TO BE AN INVALID CONFIGURATION, ELSE THIS IS DEFINED TO BE A VALID CONFIGURATION
97
FOR EACH VALID CONFIGURATION VALID INSTANCE:
• DETERMINE MAX. VALUE OF sACL OR sVCL IN INTERNAL FROM 1 BEAT AFTER FIRST BEAT OF CONFIGURATION INSTANCE TO 8 BEATS AFTER FIRST BEAT OF CONFIGURATION INSTANCE
• DETERMINE MIN. VALUE OF sACL OR sVCL IN INTERNAL FROM 3 BEATS BEFORE FIRST BEAT OF CONFIGURATION INSTANCE TO BEAT WITH MAX. VALUE
• DETERMINE sACL OR sVCL FEATURE VALUE sACLf OR sVCLf: sACLf OR sVCLf = MAX.-MIN.
98
FOR EACH OF THE VALID CONFIGURATIONS:
• DETERMINE MEAN OF sACLf OR sVCLf OVER THE VALID INSTANCES
AMONG THE VALID INSTANCES OF THIS VALID CONFIGURATION:
• DETERMINE MEDIAN VALUE OF sACLf OR sVCLf
• DETERMINE MAX. VALUE OF sACLf OR sVCLf
IS (MAX./MEDIAN-1) < PREDEFINED THRESHOLD?
NO
YES
100
THIS IS THE OPTIMUM CONFIGURATION.
SET PACEMAKER TO OPERATE IN THIS CONFIGURATION

FIG. 3D

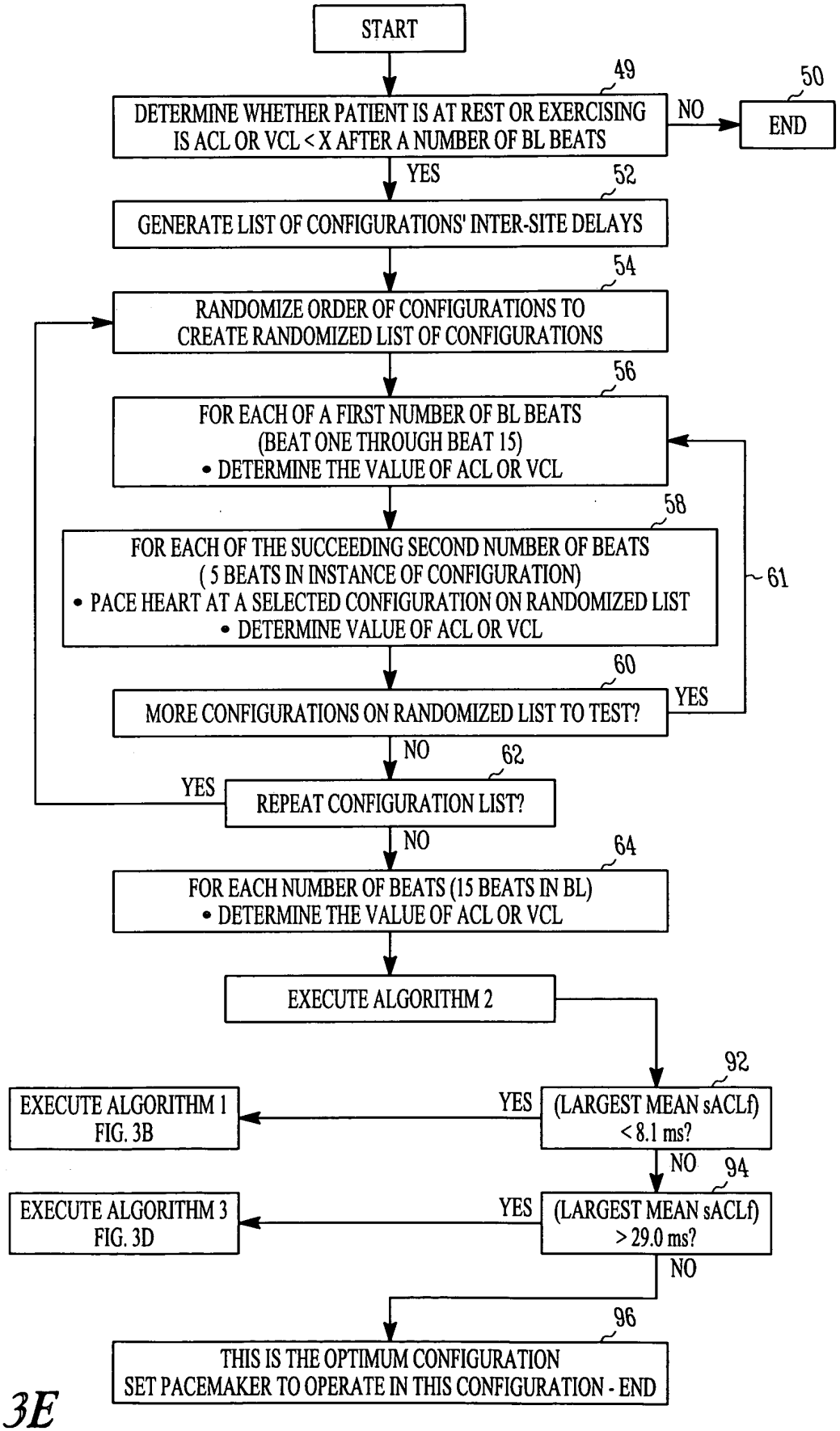
START
49
DETERMINE WHETHER PATIENT IS AT REST OR EXERCISING IS ACL OR VCL < X AFTER A NUMBER OF BL BEATS
NO
50
END
YES
52
GENERATE LIST OF CONFIGURATIONS' INTER-SITE DELAYS
54
RANDOMIZE ORDER OF CONFIGURATIONS TO CREATE RANDOMIZED LIST OF CONFIGURATIONS
56
FOR EACH OF A FIRST NUMBER OF BL BEATS (BEAT ONE THROUGH BEAT 15)
• DETERMINE THE VALUE OF ACL OR VCL
58
FOR EACH OF THE SUCCEEDING SECOND NUMBER OF BEATS (5 BEATS IN INSTANCE OF CONFIGURATION)
• PACE HEART AT A SELECTED CONFIGURATION ON RANDOMIZED LIST
• DETERMINE VALUE OF ACL OR VCL
61
60
MORE CONFIGURATIONS ON RANDOMIZED LIST TO TEST?
YES
NO
62
YES
REPEAT CONFIGURATION LIST?
NO
64
FOR EACH NUMBER OF BEATS (15 BEATS IN BL)
• DETERMINE THE VALUE OF ACL OR VCL
EXECUTE ALGORITHM 2
92
(LARGEST MEAN sACLf) < 8.1 ms?
YES
EXECUTE ALGORITHM 1 FIG. 3B
NO
94
(LARGEST MEAN sACLf) > 29.0 ms?
YES
EXECUTE ALGORITHM 3 FIG. 3D
NO
96
THIS IS THE OPTIMUM CONFIGURATION SET PACEMAKER TO OPERATE IN THIS CONFIGURATION - END

FIG. 3E

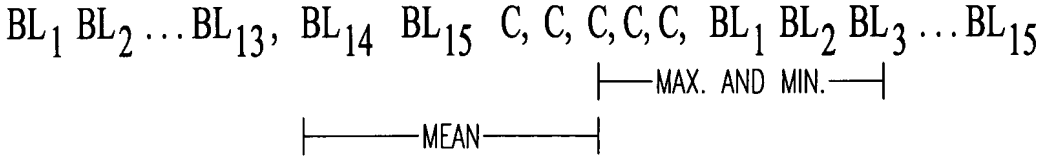

FIG. 4

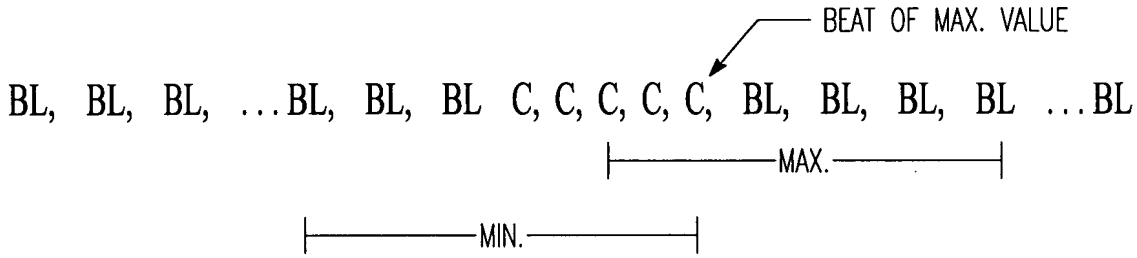

FIG. 5

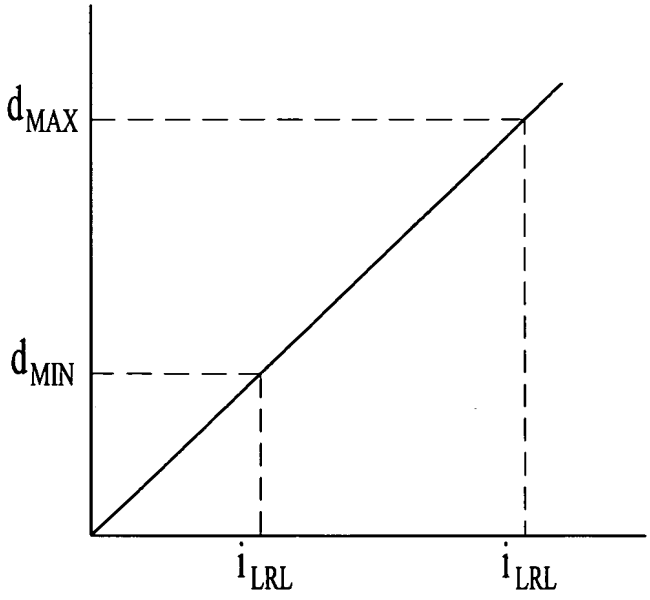

FIG. 6